

The Unique Elements of the Limestone Flora of Batu Tengar Cave (Segarong), Sabah, Malaysia.

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Abstract

Unique elements of the flora of the Batu Tengar Cave include *Begonia keithii* (Begoniaceae), a new species endemic to this hill, and the phytogeographic affinities of its flora, which are not only with the nearby Madai limestone hills, but also with limestone in Kalimantan (Borneo) and the Philippines. Notes on species of special interest, *Euphorbia lacei* (Euphorbiaceae), *Impatiens winkleri* (Balsaminaceae) and *Paraboea madaiensis* (Gesneriaceae) are given.

Introduction

Batu Tengar Cave (4° 42' 00"N 118° 00' 30"E) is located within the Segarong Protected Forest Reserve (Lim & Kiew, 1997), adjacent to the Segarong River. Commercial quantities of bird nests are still collected from the cave.

The earliest botanical collections from this locality (called 'Segarong' on herbarium labels) date from 1938 when Symington with Agama and then Keith collected a handful of plants. These few collections are, however, extremely interesting as they included the first collection of a balsam from limestone in Sabah, the succulent *Euphorbia lacei* (Euphorbiaceae) and a begonia with decorative leaves. In May 1997, as part of the botanical survey for 'The Biodiversity and Conservation of the Limestone Flora of Sabah Project', this hill was revisited to relocate these species and to make a general collection of fertile material (Kiew, in press).

The hill is now a 25-minute journey from Semporna by speedboat to the jetty built by the birdnest concessionaire on the Segarong River. It is then a short walk through cultivated land to the hill base that is surrounded by a narrow strip of forest. The summit of the hill (about 200 m a.s.l.) closest to the river shows signs of burning being bare of vegetation apart from dead tree trunks that are still standing (Fig. 1). However, the way to the cave on a well-beaten track is through primary forest that provides the damp shaded conditions that support lush vegetation. Once the cliff base is reached, the path ascends a narrow gully, where on the large scattered limestone boulders, *Impatiens winkleri* (Balsaminaceae) and *Epithema*

dolichopodum Hillier & Burtt (Gesneriaceae) are encountered in abundance.

As the path ascends, it becomes steeper and the canopy is more open and here *Begonia keithii* (the new species described below) is first encountered. Higher up on the exposed shoulders of the summit it is abundant. It is an extremely decorative species with glossy cardinal red stems that look lacquered, narrowly scolloped leaves and bright red male flower buds.

The summit vegetation is remarkable being completely dominated by a cactus-like forest of *Euphorbia lacei* with a candelabrum-like crown (Fig. 2). This is unique to Batu Tengar Cave as no other limestone hill in Sabah has this type of forest on the summit. On the sheer cliffs, *Paraboea madaensis* (Gesneriaceae) is abundant.

Phytogeographic Affinities of the Flora

Apart from the begonia, which is endemic to Batu Tengar Cave itself, two species (*Epithema dolichopodum* and *Paraboea madaensis*) are endemic to Sabah, while *Impatiens winkleri* and *Euphorbia lacei*, while not endemic, are rare in Sabah being known from a few other localities.

Impatiens winkleri was first described from south Kalimantan and in Sabah is known from just four other limestone localities all in the south east (Fig. 3). Discounting common species that are everywhere widespread, it is the only rare species from Sabah limestone that is known to occur in both Sabah and Kalimantan.

Euphorbia lacei is rare in Sabah being known from just three localities (all close to Semporna, but the other two are not limestone). However, elsewhere it is a widespread species ranging from Myanmar, though Thailand and IndoChina to the Philippines where it reaches Palawan.

Three of these species are also known from Gunung Mada. *Paraboea madaensis* is only known from Gunung Mada and Batu Tengar Cave, *Impatiens winkleri* is known also from Baturong, Batu Belas and Tempadong, while *Epithema dolichopodum* is known from six other localities, which are all located in the southeast, Batu Tengar Cave, Baturong, G. Mada and Tempadong (Fig. 3), except for one population on limestone on Pulau Balambangan and one collected by Elmer (Elmer 20569) from Tawau but without a specific locality.



Figure 1. Batu Tengar Cave, Segarong Protected Forest Reserve.
(Burnt summit visible to right)



Figure 2. *Euphorbia lacei* Craib on the summit of Batu Tengar Cave.



Figure 3. Distribution in Sabah of rare species from Batu Tengar Cave.

(■ localities; ● *Euphorbia lacei*; ○ *Impatiens winkleri* (also from Kalimantan limestone), + *Paraboea madaensis*; ▲ *Epithema dolichopodum* (endemic to Sabah, also from Pulau Balambangan and Tawau).

Conservation Status of Batu Tengar Cave

Recently, the hill was proposed as a commercial source of limestone (Robert C. Ong, *pers. comm.*). In view of its endemic begonia species, the four rare species (Fig. 3), two of which are endemic to Sabah, and the remarkable 'cactus forest' of *Euphorbia lacei*, the like of which is not known from any other limestone hill, and the possibility of other new and endemic species becoming known as research on the collections from the hill continues (e.g. the *Cyrtandra* RK4319 (Gesneriaceae) is possibly a new species), Batu Tengar Cave is one of the eight most important limestone sites (Kiew, in press) from the point of view of the conservation of plant biodiversity and it is recommended for permanent legal protection. Protection of the vegetation will also help to maintain conditions suitable for the cave swiftlets to nest which, if harvested sustainably, are a renewable economic resource for local people.

Notes on Species of Special Interest

1. *Begonia keithii* Kiew sp. nov. (Begoniaceae)

Typus: R. Kiew, S. Anthony & S.P. Lim RK4327 Batu Tengar Cave, Semporna F.R., Sabah (holo SING, iso K, KEP, L, SAN, SAR).

Figure 4.

A Begonia amphioxus foliis non peltatis tepalis feminibus 5 liberi et ovari triloculari differt.

Erect bushy, cane-like, monoecious, glabrous begonia forming clumps, producing short slender branches along the length of the stem. *Stems* woody, up to 1.5 m tall and c. 1 cm thick at base, shiny, deep crimson becoming brown at base, older nodes swollen with a conspicuous leaf scar. *Stipules* pale green suffused red, broadly elliptic, 10–18 by 8–9 mm, margin entire, apex setose, early caducous. *Leaves* alternate. Petiole slender, crimson, 3–7(–15) mm long. Lamina mid- to dark green above, sometimes mottled silver-grey, usually green beneath but sometimes suffused crimson, margin crimson, succulent and brittle, markedly unequal sided with the narrow side scarcely developed, narrowly lanceolate, 7.5 by 2.5 cm to 10 by 1.5 cm, attenuating to acute apex, main vein of base sometimes almost in line with the midrib but frequently at a 135° angle to midrib, base very variable in shape ranging from attenuated to acute point (matching the apex) and up to 6 cm long or bluntly rounded to truncate and 1.25–2.5 cm long or base scarcely developed and 0.75 cm long, margin scolloped becoming distantly serrate towards apex and base, main vein reaching to apex with a pair running almost parallel, the other lateral veins radiating into the basal lobe. Leaves decreasing markedly in size towards the stem apex. *Female flowers* solitary from lower axils, up to 3 produced before the male inflorescences develop. Pedicel pale reddish, 10–12 mm long; bracteoles absent; ovary pale greenish with wings suffused red towards margin, 3-loculate, ovoid 9–17 mm long and 7–8 mm wide narrowing to 1.5 mm below style, wings 3, equal, placentas axile, bilamellate with many ovules on both surfaces; tepals 5, free, whitish suffused reddish; glabrous, oval, 7–8 mm long, margin entire, apex rounded, outer tepals 5–6 mm wide, inner 2.5–3.5 mm wide, style and stigma pale yellow green, styles 3, 1–2.5 mm long, branching from base, spreading and bifid with a continuous twisted papillate stigmatic band. *Male flowers* produced on erect, many-flowered, twice-branched cymose inflorescences from the upper axils, 4.25–9.5 cm long; bracts not persisting; peduncle carmen, 2–4.25 cm long, branches thread-like and slightly zigzag; bracteoles reddish, lanceolate



Figure 4. *Begonia keithii* Kiew.

A Habit (x 0.4), B Male flower bud (x 1.2), C Male flower (x 1.2), D. Stamen (x 8), E Androecium (x 4), F Terminal flowers of male inflorescence (x 0.8), G Male inflorescence (x 0.4), H Female flower (front view) (x 1.2), I Styles (x 4), J Female flower, side view (x 0.8), K Capsule (x 0.8), L T.S. capsule (x 1.6).

1–3 mm long, apex acuminate, soon falling; male buds small, c. 4 mm long and carmen outside; pedicels carmen, slender, 1–5 mm long; male flowers with 4 glabrous tepals, outer two with inner surface scintillating white with carmen showing through, almost rotund, 5–7 by 4–7 mm, inner two completely white, narrowly lanceolate, 2–5 by 1–2 mm, apex rounded, margin entire; stamens c. 55–65, pale yellow green (matching exactly the colour of stigmas), forming a spherical cluster on columnar torus 1.5–1.7 mm long, filament c. 0.5 mm long, anther obovoid, 0.5–0.7 by 0.5 mm, apex deeply emarginate. *Capsule* dangling on slender thread-like stalk 2–3 cm long, ovoid and narrowed to pedicel, 18–25 by 15–25 mm; locules 3, c. 14 mm long, not reaching to pedicel or apex; wings 3, isomorphic, broader distally and 8–12 mm wide, wing tip slightly rounded or sometimes acute, becoming dry and papery and dehiscing along the junction with locule, styles caducous. *Seeds* broadly ovoid, c. 0.35 by 0.2 mm, testa strongly reticulate.

Distribution: Endemic to Batu Tengar Cave (Segarong Cave), Semporna Protected Forest Reserve, Sabah, Borneo.

Habitat: In light shade to full sun, growing in rock crevices on the tower karst limestone hill, dominating the exposed shoulders of hill where it forms thickets with its woody cane-like stems.

Specimens examined: Symington & Agama 9315 20 July 1938 (K, SING), Keith A9416 26 Aug 1938 (K, SING), Kiew *et al.* RK4327 9 May 1997 (K, KEP, L, SAN, SAR, SING).

Notes: A most decorative begonia, it has polished crimson stems that appear lacquered, dainty scalloped leaves with a crimson margin and the many tiny, carmen, heart-shaped buds of the male flowers set on slender sprays.

It has yet to be found on other limestone hills in Sabah or elsewhere. In possessing an erect, bushy habit, female flowers with 5 petals, 3 bifid styles and a 3-loculate fruit with 3 equal wings, it conforms to Section *Petermannia*, except that its male flowers have 4 tepals. (Section *Petermannia* is characterised by 2 tepals).

In its cane-like habit, narrow leaves with the pointed apices and serrate margin, solitary female flowers, male flower with 4 tepals, it most resembles *B. amphioxus* Sands. Sands (1990) had already noted this similarity remarking that the two species ‘may be at least very closely allied’. The two species are, however, readily distinguished by the suite of characters listed in Table 1.

This begonia is named for H.G. Keith, in 1925 Assistant Conservator of Forests in the then British North Borneo, rising in 1931 to Conservator.

He survived internment during the war returning to Sandakan in 1946. It was he who in 1938 collected from Batu Tengar Cave this begonia, the first collection of a balsam from Sabah limestone and the *Euphorbia*.

Table 1. Characters that distinguish *Begonia keithii* from *B. amphioxus*.

Character	<i>keithii</i>	<i>amphioxus</i>
Max. stem length (cm)	150	75
Stem colour	glossy crimson	green
Petiole length (mm)	3-7(-15)	(10-)15-55(-60)
Petiole colour	crimson	light green
Leaf	not peltate	peltate
Leaf pattern	unpatterned or grey mottled	red spotted
Tepals female flower	5, free	3-4(-5), joined
No. styles	3	2(-3)
No. locules	3	2
Capsule shape	ovoid	columnar
Capsule size (mm)	(18-)20-25 x 15-25	(9-)10-13 x (5-)6-7
Length capsule stalk (mm)	20-30	2(-2.2)
Wings	3, equal	2(-3), third shorter
Length male inflorescence (cm)	4.25-9.5	up to 3
Colour of male buds	carmen	white

2. *Euphorbia lacei* Craib (Euphorbiaceae)

Shaw (1975) listed this *Euphorbia* as one of the seven species of Bornean Euphorbiaceae that are confined to limestone. He also expressed uncertainty as to its identity recording it as *E. sp. cf. lacei*. Now that more specimens are available and field observations could be made, its identity is confirmed as typical *E. lacei*, which differs from the other Malesian limestone succulent *Euphorbia*, *E. antiquorum* L. in its longer spines, more distant spine shields with deep sinuses between them.

Euphorbia lacei is indeed a remarkable plant, which on the summit of Batu Tengar forms a "cactus" forest, unique for limestone in Malaysia. It grows to 4-5 m tall with a stem diameter of 4.5-5 cm, the lower trunk is bare but the upper branches curve outward giving the plant a candelabrum-like appearance (Fig. 2).

However, in Sabah it is not confined to limestone. One of the localities quoted by Shaw is Mt Sidungol (correctly spelt Sironjol), which is one of the rocky peaks of Timbun Mata Island, which is of volcanic conglomerate. Staff of the Forest Department in Semporna have also collected it from the summit of Bohey Dulang Island (also of volcanic conglomerate) and are successfully growing it as a pot plant at their office.

In Borneo, *E. lacei* is presently known only from these three dry rocky summits close to the coast near Semporna (Fig. 3). Outside Malaysia it is widespread. It is recorded from Myanmar and Laos, from limestone in southern Thailand and also from the Philippines. Merrill (1923) recorded it (under the name *E. trigona* Roxb.) from Luzon, Mindoro and Palawan describing its habitat as 'in thickets and on limestone cliffs, usually along the seashore ascending to 300 m'. The local names that Merrill cites (*suda-suda* and *tuba*) are the same as Keith recorded in the Kedayan language – *tuba suduh* (Keith 9415). *E. antiquorum* in Peninsular Malaysia is also called *sudu-sudu* in Malay on account of its leaves that are spoon-shaped. The name *tuba* suggests that this species may be used as fish poison.

Specimens examined: Semporna District: Batu Tengar Cave Keith A9415 26 Aug 1938 (K), Kiew *et al.* s.n. 9 May 1997 (SING). Mount Sidungol Keith A9337 18 July 1938 (K, KEP).

3. *Impatiens winkleri* Hook f. (Balsaminaceae)

Impatiens winkleri was first collected from Sabah by Keith in 1938 from Segarong F.R. Our survey confirms that it grows on limestone on Batu Tengar Cave and also that it is more widespread growing on several limestone hills in S.E. Sabah, namely Bukit Baturong, Gunung Madai, Batu Belas and Tempadong (Fig. 3). It was originally collected from south Kalimantan by Hubert Winkler from Batu Babi but he did not record whether from limestone. More recently it was recollected from south Kalimantan from limestone on Gunung Serempaka. It therefore appears to be confined to limestone. It has not been collected from Sarawak.

Its habitat is typical of limestone balsams (Kiew, 1991) in that it grows only on limestone boulders and ledges close to the cliff base in particularly damp and deeply shaded conditions. Where conditions are suitable, e.g. in narrow gullies, it forms thickets. As forest surrounding the base of the limestone hills is cleared for agriculture, this habitat is particularly vulnerable to exposure to light and drying out, which will endanger the continued existence of this species. Already the undergrowth around the base of the hills at G. Madai and Batu Tengar Cave is disturbed by birdnest collecting activities.

Impatiens winkleri is a giant balsam up to 2 m tall. The fleshy dark green trunk ranges from 4.5 to 6 cm in diameter at the base and bifurcates or trifurcates at about 1.5 m to produce a spreading crown of succulent branches. As the branches grow, they bend under their weight and many erect branches are then produced from the upper side of this horizontal branch (Rauf's tree architecture model). The thick fleshy branches are brittle and frequently break off to be replaced by many, more slender stems.

This life form is not shown on herbarium specimens as only the terminal portion of the branch with its bunch of leaves and flowers fits onto the sheet, misleadingly giving the impression it is a small herbaceous species. Indeed, Hooker (1910) described the stature as 'humilis', i.e. low growing, and the stem as at least 1 m tall and 2–3 cm thick. Shimizu (1970) identified specimens as *I. scortechinii* Hook. f., a herbaceous species from Peninsular Malaysia that grows to about one meter tall.

Among all the limestone balsams in Malaysia, *I. winkleri* in its tall 'trunked' habit most resembles *I. mirabilis* Hook. f. from limestone in the extreme north of Peninsular Malaysia and S. Thailand. However, it differs from *I. mirabilis* as its trunk base is not swollen (*I. mirabilis* is called the 'gouty balsam' because of its swollen base). Its habit, broad leaves and white flowers make *I. winkleri* distinct from all other Bornean balsams.

Limestone balsams in Peninsular Malaysia, are very biodiverse with about ten species, of which six are endemic to Peninsular Malaysia, three are endemic to the region spanning northern Malaysia and peninsular Thailand, and one is shared with Sumatra. In Sarawak, there are at least four species (most still unnamed) collected from the Bau area and the Mulu National Park and at least three of these are endemic to Sarawak. However, in Sabah there is just *Impatiens winkleri*, which also occurs in S. Kalimantan. This mirrors a pattern seen in several other genera of herbs, e.g. *Chirita*, *Monophyllaea* and *Paraboea* in the Gesneriaceae, where biodiversity decreases from Peninsular Malaysia, to Sarawak, to Sabah where few or no species are found (Kiew, in press).

Specimens examined: Borneo: South Kalimantan – Batu Babi et Lumnovia *H. Winkler* 2866 (type, drawing at K), G. Serempaka *J. Dransfield* JD2318 (L); Sabah – Batu Tengar Cave *Keith* A9329 20 July 1938 (K), *R. Kiew et al.* RK4327 (SAN, SING), Baturong *Lim S.P. et al.* LSP713 12 June 1996 (SAN, SING), *R. Kiew* RK s.n. 12 June 1996 (SING); G. Madai *Mansus et al.* SAN 117117 (K, SAN), *Lim S.P. et al.* LSP671 9 June 1996 (SAN, SING), Batu Belas, Segama River *J.H. Beaman et al.* 10131 13 June 1984 (K), Tempadong, Segama River *J.H. Beaman et al.* 10091 (K).

4. *Paraboea madaiensis* Xu & Burtt (Gesneriaceae)

Previously recorded only from Gunung Madai (Xu & Burtt, 1991), it is abundant on the exposed summit and cliffs of Batu Tengar Cave. Our local guides collected plants for medicine. However, since a sizeable population grows on inaccessible sheer cliffs, it is unlikely that harvesting this species for personal use will endanger the population.

Our informants (a local villager, a birdnest collector and a forest guard) used it in several remedies:

1. Used fresh, the leaves are put in hot water and the vapour is inhaled to reduce fever in adults,

The smoke from burning leaves is used to:

2. Quieten crying babies, and
3. In adults, to clear the eyes if they are cloudy.
4. The plant can be used after childbirth but our informants were unable to give precise information on how it is used.

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